

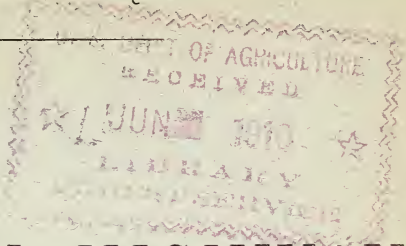
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BULLETIN No. 13.

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF ROAD INQUIRY.



KENTUCKY HIGHWAYS.

History of the Old and New Systems.

By M. H. CRUMP, C. E.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF ROAD INQUIRY,
Washington, D. C., February 20, 1895.

SIR: I have the honor to submit herewith a paper on Kentucky highways, containing a full history of the old and new systems of road building in that State, prepared by Maj. M. H. Crump, member of the National Advisory Committee on Roads. The improvement of public roads was begun in Kentucky in the early part of the present century, and to-day few States can boast a better or more extensive system of macadamized highways.

Since the fundamental principles of road building remain always the same, an account of the early methods employed in this State must be of general interest.

I would therefore recommend the publication of this paper as Bulletin No. 13 of the Office of Road Inquiry.

Very respectfully,

ROY STONE,
Special Agent and Engineer.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

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KENTUCKY HIGHWAYS.

HISTORY.

As early as 1779 the State of Virginia appointed commissioners to construct a road over the Cumberland Mountains to the "open country in Kentucky, and to cause such road to be opened with all convenient dispatch, and cleared in such a manner as to give passage to travelers with pack horses." These commissioners were authorized to call on the local county authorities for guards to protect workmen from Indians.

In 1785 commissioners were appointed to open a wagon road from the head of James River, in Virginia, by way of Kanawha Falls, to Lexington.

Kentucky became a State June 1, 1792, and passed its first road law February 25, 1797, a law very similar to that of Virginia, which was, in turn, an adoption of the English road law that has prevailed for ages. Under its provisions applications were made to the county court to open a road to the court-house, to a public warehouse, landing, ferry, mill, coal or iron works, the seat of government, and a few other places. Thereupon three or more suitable persons, termed viewers, were appointed, who examined the route and reported on the same, as to comparative advantages and disadvantages. Summonses were then issued to the owners of lands through which it passed and, if any owner so desired, a writ of *adquod damnum* should issue. "When twelve freeholders are impaneled, who are not related to either party, they meet on the ground in dispute, and while there, on pain of being discharged from inquest and immediately imprisoned by the sheriff, take nothing either of meat or drink from any person whatever, from the time they shall come to said place until the inquest is sealed." Thus the damages are fixed which the county court levies on the county.

For the general supervision and care of the roads the county divides them into precincts, each consisting of a certain number of miles, over which an overseer or surveyor is appointed, whose duty it is to look after the repairs, clear away obstructions, and do other such work.

LABOR.

Under section 4: "All male laboring persons sixteen years and older, except masters of two or more male laboring slaves sixteen years or more, are compelled by the court to work on some public road. Every

person so appointed, who, when required by the overseer or surveyor, without legal cause or disability, fails to attend with proper tools, or who shall refuse to work when there, or furnish an able-bodied substitute, shall be fined the sum of seven shillings and sixpence for every day's offense, to be paid by him or his parent, master, or guardian to the overseer, before any justice of the peace in the county, one-half of which goes to the overseer, the other half to the further improvement of the road."

Under section 6: "Every surveyor shall keep the road well cleaned, smooth, and at least thirty (30) feet wide, with a signboard at every fork or crossroad, giving the direction and distance to the most noted place to which the road leads. He shall also provide bridges and crossways leading to same, not less than twelve (12) feet wide wherever necessary, and for such purposes may go on adjoining lands for such earth, stone, timber, or other such material as is needed, which, if desired, shall be appraised by two honest housekeepers. He may also impress wagons, draft horses, oxen, together with harness and drivers, the services of which shall be valued by two honest housekeepers. Every surveyor who shall fail to do his duty shall forfeit fifteen shillings for each offense."

The county court was also authorized to contract for building bridges, and two adjoining counties could join for constructing a bridge common to the two. This act was amended in 1801, fixing the width of all highways and principal roads at not less than thirty feet, except that when it was deemed necessary the court could make them 40 feet wide, and so smooth that carriages could pass over them with convenience. In 1804 an act was passed exempting any and all ministers duly qualified to preach the gospel from working on the highways. Nor were the surveyors permitted to summons the hands to work the roads on election days, or when muster or battalion or regimental drills were ordered. With slight changes this law has remained in force as the general road law of Kentucky from 1797 to June 14, 1894, when a new law came into effect.

PROMOTION OF PUBLIC HIGHWAYS.

Few States have been more liberal in promoting public improvements than Kentucky, especially in the matter of highways, railroads, and waterways. The public system of macadam and telford roads which traverse the State was begun as early as 1810 and was carried on most actively to its present perfection, largely through State and county assistance. So little is known at this day as to the methods of securing the money and constructing these admirable highways, the excellence of the engineering skill and the durability of the workmanship, that it will not be considered amiss, I hope, if a slight sketch of these improvements is given here. In 1810 an act was passed authorizing the construction of a turnpike from the county of Madison, through the county of Lincoln, to the lower Goose Creek salt works,

in what is now Clay County. On this road salt packers were permitted to travel free of toll, and all persons living within 4 miles of it were required to assist in keeping it in repair. The Triplett's Creek turnpike was chartered in 1812, to be 30 feet wide on good ground, and 60 feet on low or wet ground, with a fine of \$10 for any obstruction. In October, 1818, an act was passed opening a road from Mount Sterling, through Prestonburg, to the Virginia line, and \$1,500 was allowed for the survey. In 1823 there was a lottery authorized by law to secure not exceeding \$3,000 for constructing a road from the Beaver Creek Iron Furnace (Bath County) to Prestonburg. But it was not till the days of the great Henry Clay that Kentucky began to lead the way along the line of internal improvements.

In the years 1823, 1824, and 1825, acts were passed for the building of turnpikes from Bowling Green to Clover Creek on the Ohio River, from Franklin to Owensboro, from Lexington to Ghent on the Ohio River, and from Georgetown to Cincinnati, with a toll rate of $6\frac{1}{4}$ cents for each horse to every wagon, carriage, or vehicle. All the roads were under the supervision of competent engineers, and none were less than 30 feet wide. From Collin's History of Kentucky I find that as early as 1784 Virginia made all roads to and from the court-house of each county, and all public roads were to be 30 feet wide and to be kept well cleared from woods, bushes, and other obstructions. An act, as early as 1793, appointed commissioners to receive subscriptions in money, labor, or property for clearing a wagon road from Frankfort to Cincinnati. In 1795 there was an act for a wagon road to commence in the neighborhood of Crab Orchard and terminate on the top of Cumberland Mountain in the gap through which the present road to Virginia passes. This was paid for out of the State treasury, and was opened in the summer of 1796.

The origin of turnpikes in Kentucky is said to be as follows: A turnpike road, or road on which turnpikes or tollgates are established by law, and which are made and kept in repair by the toll collected from travelers who use the road, the road being merely graded or ridged in the center by throwing up earth from the sides in a rounded form, is usually confounded with the modern macadam or telford road, which is an artificial structure composed of broken or carefully placed stone. The name "turnpike" comes from medieval days, when graded roads were first constructed in England, and travelers were notified that they were expected to stop and settle before proceeding farther, by the presence of a pike across the road. When the fees were collected the pike was turned and the traveler proceeded on his way. No macadamized road, or turnpike, was constructed in Kentucky prior to 1829. In March, 1797, an act was passed authorizing the erection of a turnpike at some convenient place on the Crab Orchard and Cumberland Gap road, beyond where the road from Madison Court-House intersects the same. This turnpike or tollgate was let to the highest bidder, who had the right and privilege to receive the following tolls: For

every person (except mail carriers, expressmen, women, and children under 10 years), $12\frac{1}{2}$ cents; each horse, mare, and mule, $12\frac{1}{2}$ cents; two-wheeled carriages, 50 cents; four-wheeled carriages, \$1; every head of neat cattle going east, $4\frac{1}{8}$ cents. All surplus tolls, after keeping the road in repair, went to the tollgate keeper. The first appropriation from the State for road purposes was in December, 1821, when \$1,000 was set apart to improve the road leading from Lexington to Nashville, Tenn., from the point where the said road crosses the Rolling Fork to and over the summit of Muldrows Hill.

The purchase of tools for repairing roads was first authorized by the State in December, 1822, when the county courts were directed to make a levy for the purpose. As before stated, the first impulse to the building of artificial or stone roads was given when the board of internal improvements took up the matter, and Governor Joseph Desha, in his annual message, took strong grounds in favor of State aid for the turnpike leading from Maysville, through Paris and Lexington, to Frankfort. He suggested other important roads and closed as follows:

Let the common-school fund (\$140,917), the proceeds of the sales of vacant lands, the stock in the State banks (\$781,238), and all other funds which can be raised by other means than taxes on the people, be vested in the turnpike roads, and the net proceeds arising from tolls on the roads be forever sacredly devoted to the interests of education.

The Maysville and Lexington turnpike was incorporated anew in July, 1827, with \$320,000 capital stock, of which, at any time in three years after complete organization, the United States Government was authorized to subscribe \$100,000 and the State of Kentucky a like sum. The Secretary of War ordered a survey of a mail road from Zanesville, Ohio, through Maysville, Ky., Lexington, and Nashville, Tenn., to Florence, Ala., which was begun May 12 of the same year, but a bill with appropriation for this road, though introduced in Congress, failed to become a law.

The town of Maysville, with 2,000 inhabitants, then procured a charter, January, 1829, for the Maysville and Washington pike, subscribed \$20,000 of stock and began work on the ensuing 4th of July, and steadily pushed this short road to completion on November 7, 1830. Maximum grade is $4\frac{1}{2}$ degrees, or a rise of nearly 8 feet in 100 feet.

In 1830 a bill passed both houses of Congress which appropriated \$150,000 to the capital of the Maysville and Lexington Turnpike Company, which bill Andrew Jackson vetoed May 27, 1830. In July of the same year the legislature of Kentucky made it lawful for the governor to subscribe not exceeding \$25,000 to the stock of the company, none of which could be paid until three times that amount had been paid in by the stockholders of the company. During the same year Paris subscribed \$30,000, Lexington, \$13,000; Millersburg, \$5,200; Nicholas County, \$8,000; and Maysville, \$10,000 additional. With added subscription 31 miles were soon under contract. In 1831 the State subscribed \$50,000, and during the next five years the total amount of State

aid and other stock amounted to \$213,200, just one-half the entire cost of the road. By November, 1837, the subscriptions of individual stockholders in the incorporated road companies amounted to nearly or quite \$200,000, and in the meantime the State had permanently invested the sum of \$2,509,473. Three hundred and forty-three miles of macadamized road were completed and 236 were under contract, in addition to 30 miles under construction in which there was no public aid of any description, making a total of 609 miles.

The State paid the following amounts to the great thoroughfares mentioned below, in addition to what was subscribed by individual and corporation stockholders:

Lexington to Maysville, 64 miles	\$213, 200
Lexington to Frankfort, 27 miles	78, 122
Frankfort to Louisville, 52 miles	65, 000
Covington to Lexington, 85 miles	200, 406
Louisville via Frankfort to Crab Orchard, 123 miles	260, 727
Louisville via Bardstown to Tennessee line, 144 miles	500, 210
Louisville, Bowling Green, Franklin, and Tennessee line, 145½ miles	442, 182
Total	1, 749, 847

The cost of the road, including bridges, from Louisville via Bardstown, Glasgow, and Scottsville to the Tennessee line was \$970,000; and that of the Maysville and Lexington pike, including 13 tollhouses and 6 covered bridges, was \$426,400—an average of \$6,662.50 per mile for the last and \$6,750 per mile for the first.

These roads were all constructed on either the macadam or telford plan, under the supervision of competent engineers. The macadam was composed of 8 to 10 inches of broken stone, preferably limestone, average weight, 6 ounces. The roadways were graded from 20 to 30 feet wide, well drained and ditched, and metaled from 12 to 20 feet wide. The entire width of the road was from 30 to 60 feet, with frequently metaled portions 18 feet wide, and a graded, or summer road, 16 feet wide. The total cost per mile, as shown above, was from \$6,662.50 to \$7,359, including tollhouses and bridges. All the metal was broken by hand, and the work done by contract. The bridges over the rivers cost from \$36,000 to \$60,000, with spans of 176 to 240 feet; those over small streams and creeks ranged from \$500 to \$8,000, with spans from 20 to 100 feet.

Many State roads were opened prior to 1835 which were surveyed and opened entirely at the cost of the county. Others were built entirely by the State, and were simply graded, ditched, and drained, and were known as dirt or mud pikes, sometimes simply as graded roads, occasionally with tollgates upon them. Such are the following:

Crab Orchard to Cumberland Gap, cost to State	\$6, 655
Owingsville to Big Sandy, cost to State	168, 783
Mount Sterling to Virginia line, cost to State	23, 243
Pikeville to Landing Gap, cost to State	6, 324
Mouth of Troublesome Creek to Landing Gap, cost to State	1, 180

In the year 1837 the State had in its employment and principally engaged in road work the following:

	Per year.
Chief engineer, at a salary of	\$5,000
Two engineers, salaries each	3,000
One engineer, salary	1,600
Five assistants, salaries each	1,500
Four assistants, salaries each	1,100

This makes a total of \$24,500 for engineering service alone. In 1839 the amount had grown to \$31,675. The work done by these highly educated and eminently practical men is as good as the day it was finished, and since the same system can be used to-day it is thought best to give the general specifications prepared by Sylvester Welch, chief engineer, for the construction of artificial, or stone, roads:

CONSTRUCTION OF ARTIFICIAL, OR STONE, ROADS.

1. The width of graded surfaces in deep cuttings, on high embankments, and along hillsides, when it can not conveniently be made wider, shall be at least 30 feet from the bottom of the inside slope of the ditch on one side to the corresponding point on the other side of the road; in all other places the road shall be at least 40 feet wide, in order to admit of a summer or dirt road alongside the stone pavement. The transverse section of the roadbed is to be level from a point 3 feet from the bottom of the slope of the side ditch on one side to a corresponding part on the other side. The road in the direction of its length should be as nearly level as possible; the inclination should not in any case exceed 2 degrees, equal to 1 foot to 28.65 feet. After the excavations and embankments are made, the latter should be permitted to settle from six to twelve months, during which time the travel in the direction of the road should be permitted to pass over it; the roadbed should be leveled and rolled with a heavy roller until it shall become firm and compact, and if the embankments have settled below the prescribed grade they should be raised by the addition of more material.

The roadway may consist of a pavement covered with broken stone (telford) or may consist of broken stone alone (macadam). It should not be less than 18 feet wide and formed of conical-shaped stone, set with their points up, or of flat stones, set with the thickest and longest edge along the roadbed. When the pavement is made of flat stones, or any stones that present a flat surface at the top, such surface of each stone is to be broken off with a hammer, so as to reduce it nearly to an edge or point. The spaces between the stones thus prepared are to be filled up with stone chips, carefully placed in by hand, so that all the crevices shall be filled. The filling should be raised a little above the top of the broken stones. The whole pavement is then to be rammed with wooden rammers, as heavy as can be conveniently worked by two men. The pavement is to be covered with a layer of stones broken and laid in the following manner: Hard compact limestone or other strong stone is to be broken into pieces as nearly cubical as possible and not exceeding 5 ounces in weight; they are to be broken at points not on the roadbed and are to be kept from fine dust. The stones are to be carted onto the road and spread over it so that the small and large ones shall be intermixed in a manner to cause them to pack closely together. This layer of broken stone should be from 6 to 7 inches deep or thick in the center of the road and should slope off toward the sides, so as to give the surface such a curve that the cross section will be an ellipse with a semiconjugate diameter of 5 inches and a transverse diameter equal to the width of the pavement. After the stones are leveled the roadway should be rolled with a heavy iron roller until it becomes compact. Such is the telford system.

When the roadway is made entirely of broken stone (macadam system) they should be put on in layers. The first, or lower, layer should be about 7 inches thick, or deep; the stone should be broken into cubical pieces not exceeding 8 ounces in weight; they shall be spread evenly over the roadbed, and the large ones so mixed as to pack well together; this layer should be rolled with a heavy roller, and may be traveled over with carts, wagons, etc., until it becomes compact and firm; it should be raked and kept level during the time of rolling or the time the carts and wagons pass over it. The second, or upper, layer should be at least 5 inches thick in the middle and should slope off toward the sides, so as to form an elliptical curve, as above described for the layer of stone which immediately covers the pavement; these stones should be broken into cubical pieces, not exceeding 5 ounces in weight, and should be carted on the road in a manner above described for the layer which immediately covers the pavement.

Side ditches shall be cut out so that the bottom angle in the highest part of the ditch shall be at least 18 inches below the middle of the roadway; and the bottom of the ditch shall descend both ways, from such high part toward the culvert or drain, or toward some place where the water will pass from the road; the earth taken from the side ditches should be placed upon the part that is covered with stone, so as to raise it about 6 inches next to the stone; it should slope off toward the ditch when the roadbed is made wide; the part intended for a summer road should be raised partly with gravel, if it can be procured conveniently.

When the road passes over level, wet ground it should be raised above the common surface from 1 to 2 feet; ditches from 2 to 4 feet or more deep, and 2 feet wide at the bottom, should be cut along each side of the road at a distance of 8 feet or more from the common road ditches; these large ditches should be so constructed as to carry the water to the common drains of the country; communications between them and the common side ditches should be made at intervals of a few hundred feet, and the slopes of the large ditches should generally be made with a base of about 1 foot to each foot of rise. After the roadway is finished and rolled, the ditches, culverts, and drains are to be cleared out, so as to give passage to the water, and on the surface of the road there should be placed blocks of wood sufficiently large to obstruct the passage of wagons, and at intervals of about 100 feet; these blocks should be changed from time to time, during several months, from one side of the road to the other, in such a manner as to oblige teams and travel to pass over the outer surface.

Under these specifications more than 1,000 miles of splendid metal roads have been constructed in the State, but there remain some 30,000 or more miles, the greater portion of which are almost impassable for several months in the year, and the majority of which have never been in a condition to carry more than half a load.

The legislature of 1894 passed an act which became a law June 14, 1894, which is a great improvement on the old law of 1789, and its numerous amendments, and, while by no means all that is needed, it is a step in the right direction. The following are the most essential features of the law, known as the Sims road law:

The fiscal court of each county shall have general supervision of all the public roads therein. The public roads shall be maintained either by money taxation or by hands allotted to work thereon in the discretion of the fiscal court. The fiscal court shall have full power and authority to levy an ad valorem tax for road and bridge purposes, not exceeding 25 cents on each \$100 worth of property, assessed for State and county taxation, and also a per capita tax of not exceeding \$1 on each male citizen of the county, liable to work on the roads, between 18 and 50 years of age.

The fiscal court of any county wherein the roads are worked by the taxation system may appoint a supervisor, who shall be a competent engineer of roads in and for the county, and who shall hold office for the term of two years.

SEC. 29. In counties wherein roads are worked by taxation it shall be the duty of the supervisor to let out to the lowest and best bidder the working and keeping in repair of all roads in the county.

The said court shall provide a period in each year within which the leveling and grading of roads shall be done, but such period shall not extend beyond the 1st of September in any year.

SEC. 36. All male persons confined in county jails or workhouses, under judgment of a court directing that they may be worked at hard labor, shall be available to the supervisor or overseer for the purpose of working them on the public highways.

PLANS AND SPECIFICATIONS FOR GRADING, DRAINING, PAVING, METALING, AND GRAVELING HIGHWAYS IN KENTUCKY.

GRADING.

Under this head will be included all clearing and grubbing, excavation and embankment required for the roadbed, or in any connection with, or incident to, the construction or drainage of the same, or the change or crossing of roads or streams. All grading shall be done by the cubic yard, measured in excavation, and paid for as excavation only. The roadbed will be graded with such widths, depths, and slopes of cutting and filling as the engineer or supervisor may determine, and such ditches and drains shall be dug within and without the limits of the road as he shall direct.

CLEARING AND GRUBBING.

The entire width of the roadway, which shall not be less than 30 feet, shall be cleared of all trees, bushes, and other perishable matter. Clearing shall include the cutting of such trees outside of the right of way as the engineer or supervisor may deem necessary for the safety of the road. All stumps on the ground where embankments are to be made must be cut even with the ground and none left within 2 feet of subgrade, in any embankment. All fences, buildings, and wood on the line of the road, if not removed within a reasonable length of time after notice is given, shall be cleared off by the contractor, piled in such a manner as the supervisor or contractor may direct, and preserved for the use of the owner, but at his expense. Grubbing shall be required for the entire width of all embankments which are less than 2 feet in depth. The contract price for excavation must cover clearing and grubbing.

EXCAVATION.

Excavation will be classified as follows: Earth, loose rock, and solid rock.

Earth will include loam, clay, sand, gravel, mud, decomposed rock and slate, shale, and bowlders containing less than 1 cubic foot of material, and all other material of any earthy kind, stiff or compact; in fact, anything that can ordinarily be worked with a pick and without blasting.

Loose rock will include all bowlders and detached masses of rock measuring more than 1 cubic foot and less than 1 cubic yard; also all coal, slate, shale, and other rock which may be removed with occasional blasting only.

Solid rock will include all rock occurring in masses of more than 1 cubic yard, and which in the judgment of the engineer requires blasting.

In road alterations, or a change of water courses, the contractor will be entitled to the same compensation as for like material for the same section or mile. Where material for embankments is not supplied from the excavation it shall be supplied by widening the cuttings to such an extent as the engineer may prescribe,

or from outside the roadway, at such places and in such manner as he may prescribe. When material is so taken from outside the roadway, care must be had that the space from which it is taken is left in such a manner that a ready and accurate measurement may be made by the engineer of the quantity obtained, and that as little damage as possible is done to the adjoining lands in the way of forming pits or stagnant ponds; to this end no material should be taken until the engineer has marked out the ground; when possible he will designate the depth of the excavation. When the excavation exceeds the embankment, the excess shall be deposited on the sides of the embankment, or at such points as the engineer may direct. All material that may slide from the sides of the cuttings, if in the opinion of the engineer they are attributable to the carelessness or negligence of the contractor, shall be removed by him at his own cost to such place as the engineer may direct, but if not thus attributable, such allowance for the removal will be made as may be deemed just and equitable.

EMBANKMENT.

Embankments shall be constructed according to instructions from the engineer or supervisor, either by dumping from the grade or in layers of such thicknesses as he may require. Such additional height above grade shall be given to embankments as may be deemed necessary to compensate for shrinking and washing. Embankments about masonry of all kinds shall be built at such time, in such manner, and of such material as the engineer or supervisor may direct. They shall not be constructed in wet weather of such material as in the opinion of the engineer will slide when wet, nor with soft mud, muck, or perishable material of any kind.

When the embankment is formed from ditching or borrowing on either side, the crest of the slopes of the ditches, or borrow-pits, shall in no case approach within 6 feet nor within double the depth of the ditch or pit of the foot of the proper embankment slopes. New channels and ditches for water ditches shall be at such distance from the bottom of the slopes as the engineer may direct.

Embankments liable to wash from overflow or otherwise will be protected, when required by the engineer, with stone slope walls, riprap, or in such other manner as he may direct.

The usual form of the roadbed shall be elliptical, and elevated 4 inches higher in the center than at the edges, which elevation will be regulated by the width of the roadbed. Before the paving, macadam, or gravel is placed on the road the subgrade must be brought to a true surface.

Upon the subgrade thus prepared there will be placed for a telford road a pavement not less than 8 inches thick, composed of selected stone, carefully set edgewise by hand, and of an average size of 4 inches by 8 at the base and sloping upward to 2 inches by 6 inches or less. These stones must be broken down to a uniform height of 8 inches, the spaces being filled with small broken stone, so that the pavement will present a smooth appearance. On this pavement must then be spread at least 4 inches of broken stone, not exceeding $2\frac{1}{2}$ inches in any direction. It shall be hard, sound, durable stone (limestone preferred). This metal shall be so spread as to be 6 inches in the center and 2 inches at the edges. When gravel is used instead of broken stone it must be clean and free from vegetable or refuse matter of any kind, and must not contain over 15 per cent of clay, loam, or sandy matter. All pebbles larger than $2\frac{1}{2}$ inches in diameter must be broken. Both metal and gravel will be paid for by the cubic yard when spread upon the roadbed, the price to include furnishing, hauling, breaking, and spreading, and [metal and gravel] will be measured after being spread, or otherwise, as the engineer may direct.

In the absence of a roller at least 3 inches of clay or earth should be carefully spread on the metal to act as a binder. On all embankments at least 3 feet of earth must be placed outside of the line of headers (the carefully set rock which holds the pavement in place). This earth should be sodded or set in grass at once.

MACADAM ROADS.

The grading and draining are the same for all systems of roads. A macadam road differs from a telford road in not having the stone subpavement. It consists entirely of broken stone, put on in two or more courses of from 3 to 6 inches in thickness. Broken stone should be of hard, sound material, broken so as to pass through a $2\frac{1}{2}$ -inch ring.

GRAVEL ROADS.

Gravel roads are constructed after the same manner as the macadam roads. The gravel should be selected with great care. Much care must be taken in spreading gravel; it must not be dumped from wagons, as this will cause irregularity in the road surface. It must be at least 12 inches deep in the center, sloping to nothing at the sides.

MASONRY.

All masonry will be estimated and paid for by the cubic yard and will include the following classes:

1. Second-class masonry will consist of uncoursed masonry, laid in cement mortar or dry, as the engineer may direct. Stones shall be not less than 8 inches thick with horizontal beds and vertical joints, which joints shall be not less than 8 inches in from the face and as much more as the stone will work. No joint to be laid more than three-fourths of an inch in thickness. The stretchers and headers to be not less than 2 feet long, to have beds not less than 15 inches wide and to be always at least as wide as they are high. One-fourth the stone in the wall must be laid as headers, the headers shall run through the wall, or interlock, or be connected in the heart of it.

2. Box culvert masonry will be generally laid dry, but this is left to the direction of the engineer. The side walls shall consist of good-sized and well-shaped stone, properly laid and bound together in each course by headers extending entirely through the wall at least every 6 feet in the length of the wall. Headers and stretchers shall be at least 15 inches wide, with a height equal to the width. The covering stones to be sound, strong, and of such shape as to form suitable joints; to be of approved thickness according to the width of opening, but in no case less than 12 inches thick, and to lie with their whole width not less than 15 inches on each side wall. The ends of the culvert must show a neat finish.

3. Retaining walls will be composed of such class of masonry as the engineer may direct.

4. Slope walls shall be of such thickness and slope as the engineer may require; the stones shall reach entirely through the wall, and must not be less than 4 inches thick, and must be made to break joints, and have their beds at right angles to the slope; joints must be close and be free from spalls.

5. Riprap shall consist of stone carefully selected and set by hand, as the engineer may direct, for the protection of masonry from earthworm.

6. Paving shall consist of carefully set stones 10 to 15 inches in depth, placed on edge so as to break joints.

7. Concrete will consist of four parts of hard, common, durable stone of approved quality, broken in pieces of uniform size, not over 3 inches in any direction, free from clay, two parts of clean, sharp sand, and one part of the best hydraulic cement, or such proportions as the engineer may prescribe, all well mixed with clear water and well rammed in its place in layers as directed by the engineer.

8. Drainpipe may be used where the quantity of water will permit and shall consist of double-strength vitrified pipe with improved socket; usual sizes will be 15, 18, and 24 inches. Before laying the pipe the bottom of the trench will be rounded so as to fit the pipe from its lower surface up to the horizontal center line, depressions being made to fit the sockets. All joints shall be cemented with pure cement mortar

and the ends protected by timber or brick, or stone masonry, as the engineer may direct.

All masonry will be estimated and paid for by the exact number of cubic yards, all rules, customs, and modes of measurement to the contrary notwithstanding, and the price will include the cost of furnishing all material.

FOUNDATIONS.

Foundations for masonry shall be excavated to such a depth as to secure a safe and solid basis, of which the engineer shall be judge; the material excavated will be classified and paid for at the rate paid for like material in grading. Timber used in foundations shall be sound white oak, such as the engineer may approve, and will be paid for by the thousand feet, B. M. The engineer will indicate size, slope, and manner of framing all timber used in foundations. Piles when used must be peeled [and be] at least 12 inches in diameter at the large and 9 inches at the small end before being pointed, will be driven to such depth and in such a manner as the engineer may direct, and will be paid for by the linear foot; counting only that portion left in at the completion of the structure.

BRIDGES.

Bridges will be constructed either of iron or wood, or iron and wood, or iron and cement; contractors will supply drawings and strain sheets with the proposals.

The iron in bridges must be of the best quality wrought iron. It must be tough, ductile, uniform in quality, with a limit of elasticity of not less than 26,000 pounds per square inch, and must stand without breaking the following tensile strains and elongation in the distance of 6 inches and area of one-half square inch:

	Per cent.
Bar iron, 52,000 pounds per square inch, elongation.....	20
Shape iron, 50,000 pounds per square inch, elongation.....	15
Plates, 48,000 pounds per square inch, elongation.....	10

All iron must be free from injurious seams or flaws, blisters, buckles, cinder spots, and imperfect edges.

GENERAL CONDITIONS.

All material used in the construction of the road will be subject to the inspection and acceptance of the engineer, who will submit them to such tests as he may desire. All rejected material must be taken away from the site of the work without delay. The contractor, when directed by the engineer, shall remove, rebuild, or make good without charge any work which the latter may consider defective, and if he shall neglect or refuse, the engineer shall cause the same to be done at the cost of the contractor.

Commodious passing places shall be made and kept in good condition by the contractor, and he shall provide and maintain good and sufficient fences for keeping up inclosures and the preservation of crops. As soon as he begins work he shall open and maintain a good and safe road for passage on horseback along the whole length of his work, and he shall be held responsible for trespasses or damage to the adjacent properties, or to the public, for any acts or omissions on the part of himself or his employees.

Quantities marked on the profile are an approximation only and will not give the final estimate; the contractor must carefully preserve all stakes and bench marks, and when lost, misplaced, or destroyed, through his negligence, he will be charged with the cost of replacing them. Estimates of the relative value of the work performed to the last day of the month, or as near it as possible, will be made by the engineer as the work progresses.

FORM OF PROPOSAL.

The undersigned certifies that the profile of that portion of the ——— road on which the work proposed for below, has been carefully examined, as well as the specifications and plans applicable thereto, and ——— hereby propose to the ——— to do all the work on certain or all of the ——— to which the prices are affixed in the following schedule, according to the plans and specifications; and on the acceptance of these proposals ——— do hereby bind ——— to enter into and execute a contract for the work at the following prices:

Miles.	No. —.		No. —.		No. —.	
	Dollars.	Cents.	Dollars.	Cents.	Dollars.	Cents.
Entire excavation, per cubic yard						
Loose rock, per cubic yard						
Solid rock, per cubic yard						
Macadam, per cubic yard						
Graveling, per cubic yard						
Box culvert, per cubic yard						
Slope wall, per cubic yard						
Riprap, per cubic yard						
Concrete, per cubic yard						
Paving, telford, per square rod						
Drainpipe, 15 inches, per linear foot						
Drainpipe, 18 inches, per linear foot						
Drainpipe, 24 inches, per linear foot						
Drainpipe, 36 inches, per linear foot						
Timber in foundations, per M., B. M.						
Timber in bridges, per M., B. M.						
Piles, per linear foot						
" in bridges, per pound						

———, the undersigned, further propose to begin work within ——— days from date of contract, and to complete contract by ——— day of ———, 18 .

——— (name of firm).

——— (P. O. address of firm).

Members of firm: { ——— .
 { ——— .
 { ——— .

References: { ——— .
 { ——— .

CONTRACT.

This agreement, made this the ——— day of ———, 18 , between ——— and ——— (who will hereafter be designated the contractor), witnesseth that the said contractor agrees to, and will in a substantial and workmanlike manner, and with the requisite labor, tools, and materials, construct and complete all the ——— on the line of the ——— road, according to the plans, specifications, and proposals hereto attached; the whole to be done under the supervision of the engineer of said ——— road and according to such working plans and instructions as may from time to time be furnished by him. The said contractor expressly agrees to commence within ——— days from the date of this agreement, and to complete the same in sections or miles ——— to ———, inclusive, by or before the ——— day of ———, 18 ; on sections or miles ——— to ———, inclusive, by or before the ——— day of ———, 18 ; and in case he shall fail to complete any of above portions of work by the time mentioned the contractor shall pay to the ———, as liquidated damages, such sums as would otherwise be due on account of work done, materials furnished, and retained percentages, but this stipulation shall not impair the right of the ——— to give notice and take possession of the work.

And it is further agreed that in case the said contractor from any cause whatsoever (unless the chief engineer shall determine that such cause arose from the acts of ——— or the authorized agents), shall not commence or regularly proceed with the work to the satisfaction of the engineer, and with sufficient force, it shall be

lawful for the ——— or the engineer to give notice in writing (to be left at the place of business of the contractor or given to him in person) requiring him to proceed with the work according to directions, and in case he shall, in the opinion of the engineer, for seven days after such notice make default in commencing or regularly proceeding with the work as required, the ——— shall have the right to employ any other person, by contract or otherwise, or by itself to proceed with the work, and shall charge over the cost of the work so done and material furnished as cash payments to the contractors; or on the expiration of said notice this agreement shall, at the option of the ———, become void, and any amount already paid to the said contractor by the ——— shall be considered the full value of the work done and materials furnished up to the time of the expiration of said notice, and all tools and all other plant which may be on or about the premises may be used by the ——— without further payment for the completion of the work. The said contractor further agrees that he will not execute any work not provided for in the specifications unless ordered in writing by the engineer or his assistant.

And it is further agreed that the engineer shall have the right to make any changes in the location or plans of the work that he may deem necessary, without extending the time of the completion thereof. At the beginning of each month the engineer of said ——— shall estimate the work done and materials furnished during the preceding month, and deliver a copy of the same to the contractor on or before the 10th day of the month, and said ——— shall pay to said contractor 80 per cent of the amount which shall appear to be due him, according to said estimate, by the 15th day of said month. Upon the completion of said work the engineer shall make a final estimate of all work done and materials furnished, and said ——— shall pay the amount which shall appear to be due according to said final estimate, less any previous payments. Said monthly estimates shall be conclusive and final until and unless a final estimate shall be made, and said final estimate shall be final and conclusive. All material estimated upon shall become at once the property of the ———.

All extra work shall be included in the estimates at a price fixed by the engineer, and be paid for according thereto and not otherwise. It is mutually agreed by both parties to this contract that the decision of the engineer of the ——— shall be final in any question which may arise relative to, or touching the same, and no notice of any hearing shall be necessary; and the said parties do hereby waive any right of action in law by virtue of the contract, so that the decision of the engineer shall be final and conclusive between the parties. In case the time for completing the work shall be extended, then all the provisions of this contract shall apply as if such extended time were the time given in this contract.

In testimony whereof the said ——— has caused this contract to be signed by its ———, and its corporate seal to be affixed hereto, and the said contractor ——— has signed ——— name, this ——— day of ———, 18 .

Attest:

{ ——— : ———.
 { ——— : ———.

—————.
 { ——— : ———.
 { ——— : ———.

SUGGESTIONS FOR CHANGING FROM THE OLD SYSTEM TO THE NEW, OR TAXATION, METHOD.

1. All main roads should be carefully measured and marked at the end of each mile by permanent stone mile posts, from the county seat to the county line.

2. All crossroads should be measured and marked in the same way.

3. All roads should be carefully examined and changes should be made where the grades can be lowered without excessive cost; this should be done before any permanent improvements are undertaken.

A grade of 2 degrees or 1 foot rise in 30 feet, or 185 feet per mile, is the greatest slope that should be given. And under no condition should the grade exceed 6 degrees, or 1 foot in 10 feet, or 555 feet in a mile.

4. In most cases profiles of each of the main roads should be made, so that intelligible estimate can be secured, and no work should be commenced until the road have a width of at least 30 feet.

5. The contractors should provide themselves with grading machines with which from one-half mile to one mile of excellent roadbed can be made in a day at a cost not exceeding \$50 per mile, as an average. With the aid of this machine the grading is easily accomplished.

6. After grading, the soft places on the various roads should be permanently macadamized. Eight feet will be sufficiently wide for the metaled portion of the road in places 5 miles or more from a village; closer, this width should be from 16 to 18 feet. The ditches should be at least 3 feet in width at the top, and not less than 12 inches deep, and the top of the grade at the center of the roadway should be at least 20 inches above the bottom of the ditches; in no case should the distance between the ditches be less than 16 feet, which should increase to 20 feet for a 16-foot stone roadway and 22 feet for one of 18 feet.

In this manner every locality of each county would soon be supplied with roads, at least well graded, leading to the county seat, to the post-office and railroad, as well as to churches and schoolhouses. The small samples of stone road scattered in this way over the county would act as object lessons, and very soon a sentiment would grow up which would demand that the gaps be filled in. Thus in a comparatively short time, and with much less money than has been uselessly expended in the past, a splendid system of improved and permanently hard roads would exist over the entire State.

With a system of keeping the roads in good repair the tollgates would disappear, greatly to the relief of both county and towns, for the tolls are a heavy tax on those who travel, and when it is considered that it costs more to travel over turnpikes with your own vehicle than it costs to travel on the railroad, one readily comprehends how much will be gained by having free roads.

CONTRACTOR'S EQUIPMENT FOR ROAD MAKING.

The first article needed is a first-class road machine suitable for grading, ditching, plowing, and draining; there should be one machine for each 30 miles. It will cost from \$225 to \$250 and will require from 4 to 8 horses and 4 men; hence can be operated at an expense of \$10 per day, and will completely grade from one-half to a mile in that time. With each road machine there should be at least 2 road plows (price, \$15 each), 2 or 3 drag scrapes (\$10 each), 2 wheeled scrapes (\$35 to \$50 each), 2 or more dump carts (\$15 to \$25 each), 1 dump wagon (\$150) for spreading macadam and gravel. If to this is added a road roller

(\$500), together with a stone crusher (\$200), and the necessary shovels, hoes, axes, and small implements, it will make, exclusive of roller and stone crusher, a first-class equipment at a cost of \$1,500 to \$3,000. With this the contractor will be prepared to make a business of road construction, and maintenance for a number of years. If the county does not furnish an engineer he must also look to this, as in this day no successful business can be carried on, or permanent road constructed, except under the close supervision of a competent engineer skilled in road making.

For the purpose of contrasting the old or "working-of-hands" system with the new or taxation system now permitted, and which is optional with all the fiscal courts in this State, suppose the county of Warren is taken: This county has 560 square miles, about 600 miles of road, and about 3,000 men subject to road labor for six days in the year. At \$1 per day, this amounts to \$18,000 for road labor alone; in addition to this, in the last ten years the county had expended \$3,500 on bridges and mud holes. Of this all the labor and much of the money expended are absolutely wasted so far as any permanent improvement upon the roads is concerned. To remedy this, the county of Warren, with a taxable property of \$10,235,000, has fixed an ad valorem rate of 9 cents on \$100 worth of property and a capitation or poll tax of 50 cents. Together with the estimated receipts from delinquent taxpayers, this will secure a cash sum of nearly \$15,000 per year, to be spent under the direction of the county judge and county attorney through a supervisor. The one essential thing lacking in the law is the provision for selecting the supervisor, who should be in all cases, if possible, a practical engineer versed in road-building. In any event the law should at least require the selection and appointment of a practical road builder. The people of the counties must be assured that the money voted for road construction and maintenance will be expended in the most judicious and economical manner. With the \$15,000 in money which will be placed to the credit of the road and bridge fund it is expected that three times the present amount of work will be done, and in less than ten years every main road in the county will be piked to the county line. This new departure has been effected within the last eight months by means of systematic and concerted action, and largely through the circulation of the literature from the Office of Road Inquiry, United States Department of Agriculture of the General Government.

CONVICT LABOR.

The State has some 2,000 or more male convicts in its two penitentiaries, a portion of whom are being worked by contractors in trades which come more or less in competition with free labor. In this day, when so much is being said and written against such competition, it behooves the lawmakers of the land to devise some method by which

such a corps of able-bodied men can be required to support themselves, and at the same time render valuable aid to the State. No better plan has been suggested than that of working the prisoners on the public highways. Several States have already begun this. Some work has been done along this line in Virginia as well as in North Carolina. Arrangements may be perfected for letting the prisoners by contract either to counties or to Congressional districts. This is a question of vital importance to the State of Kentucky. A bulletin which deals extensively with this subject is being prepared by the United States Department of Agriculture, and can be had on application to the Office of Road Inquiry of that Department.

Below are found the rules and regulations prepared for the construction and maintenance of the highways in Warren County, and which will apply, with slight modifications, to a majority of counties in the State, and may assist them in changing from the old to the new system of road improvement.

RULES FOR THE CONSTRUCTION AND MAINTENANCE OF COUNTY HIGHWAYS AND BRIDGES.

1. No permanent improvement or work will be done on any road until a careful examination is made as to the location and grade, and whenever the grade can be reduced by slight changes of location this should be done.

2. No permanent improvement will be made on a road unless it be full 30 feet wide from fence to fence, except in special cases.

3. All main highways, particularly those leading from the county seat to the county lines, towns, or villages, should be graded and drained at the earliest possible day, and preparations for the work should be made at once.

4. All roads shall be chained and permanently marked at the end of each mile.

5. Whenever the approximate cost of grading and draining shall exceed \$50 per mile, a profile shall be made showing fills, cuts, soft places, streams, and rock, and locating culverts and drainage pipes. This profile will be the basis of improvement.

6. No roadbed shall be graded less than 16 feet wide, that is between the ditches, and the crown must be at least 20 inches above the bottom of the ditches.

7. All roadbeds will be carefully ditched or otherwise drained, and in no cases shall the ditches be less than 12 inches deep, and the same width at the bottom, with slopes of $1\frac{1}{2}$ to 1 for earth; but in case of rock the sides may be vertical.

8. The crown of the roadway shall in no case be less than 8 inches high and shall increase with the width of the roadway, but not to exceed 2 inches per foot for dirt roads.

9. The maximum grade should never exceed 1 foot in 10 feet (this reduces the load one-half) and should be kept as low as 1 in 30 if possible (for this diminishes the load one-fourth).

10. For the purpose of carrying off either storm water or permanent streams, culverts, drainpipe, or water tables will be used, the size to be fixed by the engineer or supervisor.

11. All plans and specifications submitted for bids will indicate the approximate amount of earth and rock to be removed, and bids will usually be made by the cubic yard. Culverts will be paid for either by the perch or cubic yard and drainpipe by the linear foot.

12. Cross section of the roadway will be made to conform to the plan accompanying the specification.

13. Paving shall in no case be less than 8 feet wide, with not less than 2 feet of earth backing between the headers and the ditch on a level; there shall be 3 feet backing outside the headers on all fills. The paving shall consist of hard and durable stone, carefully set by hand, and when broken down or knapped shall be at least 8 inches deep, and will then be covered with an average of 4 inches of broken stone (preferably limestone) which will pass through a 2½-inch ring.

14. Macadam shall be at least 8 inches deep, and composed of hard, durable stone (either limestone or chert), of a size to pass through a 2½-inch ring. It will be carefully spread on a uniformly graded bed and must be made at least 8 feet wide.

15. Gravel must be clean, free from earthy matter, and must not contain over 15 per cent of clay or loam; all pebbles exceeding 2½ inches in length must be broken.

16. Contractors will be paid each month, unless otherwise specified, and upon estimates taken at the time. In no case will more than 80 per cent of the cost be paid until the work of construction has been inspected and received by the county authorities.

17. Bridges will be constructed of iron, wood, or the combination of the two. Contractors will usually furnish drawings and diagrams with strain sheets accompanying the proposals. All timber will be white oak, chestnut oak, or such as the county authorities may approve, and shall be entirely free from sap, wind-shakes, and loose knots, and other symptoms of decay. All iron must be of the best quality, ductile, tough, and uniform.

18. Masonry will be estimated and paid for by the cubic yard or perch.

FORM OF PROPOSAL.

The undersigned hereby certifies that he has examined the profile of that portion of the —— road on which the work bid on below is situated, that he has carefully examined the plans and specifications applicable to the said work, and hereby proposes to the —— to do all the work, on either or all of the sections to which prices are affixed on the following schedule, according to the specification; and on acceptance of these proposals do —— hereby bind —— to enter into and execute a contract for the work at the following:

Earth excavation, per cubic yard.....	\$
Solid rock, per cubic yard.....	
Loose rock, per cubic yard	
Macadam, per cubic yard	
Gravel, per cubic yard	
Box culvert, per cubic yard	
Riprap, per cubic yard.....	
Paving, per square rod.....	
Drainpipe, per linear foot.....	
Timber in foundation, per M. feet, B. M.....	
Masonry, per cubic yard	
Concrete, per cubic yard.....	

The undersigned further proposes to begin work within —— days from date of contract and to complete the same by the —— day of ——, 189 .

(Signed) _____.

